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Extracranial and intracranial vertebral artery dissections: A comparison of clinical findings

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ABSTRACT

Background: The diagnostic criteria for extracranial vertebral artery dissection (VAD) have not been standardized among stroke centers. Recent studies have shown that extracranial (EVAD) and intracranial (IVAD) VAD may be different clinical entities. In this study, we reviewed clinical findings, including image findings of VAD cases, and compared these findings to EVAD and IVAD cases to highlight the clinical characteristics of EVAD.
Methods: We searched our database to identify VAD cases registered between April 2008 and October 2014. We performed retrospective chart reviews to obtain detailed clinical information and compared clinical characteristics and radiological findings between EVAD and IVAD cases.
Results: We identified 10 patients with EVAD and 113 patients with IVAD. Clinically, patients with EVAD had initial symptoms that included significantly higher frequencies of neck pain, nausea, and vertigo, whereas medical hypertension and alcohol consumption were more commonly associated with IVAD cases. EVAD cases were also more likely to manifest as ischemic stroke. Radiologically, intramural hematomas were more commonly observed by magnetic resonance imaging (MRI) in patients with EVAD, whereas MRI and computed tomography more frequently revealed aneurysm formation in IVAD cases.
Conclusions: Our data identified the clinical differences between patients with EVAD and IVAD. When relatively young patients complain of sudden-onset neck pain and/or other neurological symptoms, MRI studies may be useful to diagnose EVAD, especially when associated with mechanical stress.

1. Introduction

Vertebral artery dissection (VAD) is a clinical entity diagnosed based on clinical symptoms and imaging findings, and is estimated to have an annual incidence of 1–1.5 per 100,000 individuals [1]. The onset of VAD can be precipitated by neck exercises or trauma, and may also occur without precipitating events in patients with systemic diseases such as fibromuscular dysplasia, Ehlers–Danlos syndrome, arteritis, and Marfan's disease [2]. VAD may manifest as either subarachnoid hemorrhage or ischemic stroke in the posterior circulation territory, and results in severe neurological deficits.

Previously, our group reported new magnetic resonance imaging (MRI) techniques for diagnosing intracranial VAD (IVAD), including basiparallel anatomic scanning (BPAS) and volume isotropic turbo spin echo acquisition (VISTA) [3,4]. The use of these imaging techniques has improved the clinical care of VAD patients. Various reports have described the clinical findings and treatment of patients with intracranial VAD (IVAD) [5]. However, only a few reports have been published concerning the radiological characteristics [2] and treatment of extracranial VAD (EVAD) [6]. Additionally, the diagnostic criteria for EVAD have not been standardized among stroke centers [7], and a recent study showed that potential risk factors may be different between EVAD and IVAD [8]. Therefore, in this study, we reviewed the clinical findings, including image findings of VAD cases, and compared these findings of EVAD and IVAD cases to highlight the clinical characteristics of EVAD.

2. Methods

2.1. Participants

We queried our institutional review board-approved database for patients with VAD diagnosed between April 2008 and October 2014. We have developed a referral system from affiliated hospitals named the Fukuoka Dissection Registry (FDR), and all VAD patients were treated at Fukuoka University Hospital to standardize the diagnostic and the treatment protocols. A retrospective chart review was performed to obtain a detailed history for each case. Clinically, we considered a possible

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VAD diagnosis when the patient complained of sudden-onset neck pain, headache, and/or other neurological symptoms, usually involving posterior circulation problems. We performed MRI, digital subtraction angiography (DSA), computed tomography angiography (CTA), and ultrasonography (US) on patients with suspected VAD. Our MRI protocol for potential VAD cases included magnetic resonance angiography (MRA), BPAS, and VISTA, as described in detail in previous reports [3, 4]. These imaging studies were carefully reviewed by our multidisciplinary group, consisting of neurosurgeons (T.M., M.O, T.H., and T.I.), a stroke neurologist (T.O.), and a neuroradiologist.

We classified image-based VAD diagnoses into three categories: "definitive", "probable", and "possible," based on the spontaneous cervicocephalic arterial dissections study (SCADS) Japan criteria [9]. A diagnosis of "definitive" VAD was made after detecting intramural hematoma using MRI and/or double lumens using DSA. Patients demonstrating double lumens using MRA or CTA, but not using DSA, were classified as "probable" VAD lesions; those demonstrating only the pearl and string sign or the string sign were classified as "possible" VAD lesions. In this study, we included "definitive" VAD lesions, regardless of the clinical symptoms. However, cases where image findings were suggestive of "probable" or "possible" VAD were also included when the clinical symptoms were indicative of VAD.

2.2. Outcome measures

We evaluated modified Rankin Scale (mRS) scores at the time of admission and every 3 months at the follow-up clinic as clinical outcome measures. At the multiple follow-up visits, the condition of the VAD was evaluated using imaging studies. MRI studies were performed at 1, 3, 6, and 12 months after onset, and then the patients were followed up annually thereafter.

2.3. Statistical analysis

To determine the differences in clinical features between EVAD and IVAD, we collected demographic data, including age, sex, lesion side, medical co-morbidities (i.e. history of diabetes mellitus, hyperlipidemia, hypertension, alcohol drinking and smoking), precipitating events, and baseline National Institutes of Health Stroke Scale (NIHSS) and mRS scores. Wilcoxon signed-rank tests were used to compare the onset ages between EVAD and IVAD cases; differences between other risk factors were compared using Fisher's exact test. We used SPSS ver. 21.0 (IBM Corp., Armonk, NY, USA) for these statistical analyses.

3. Results

3.1. Patient characteristics

We initially identified 160 cases of brain artery dissection, diagnosed during the study period, in our database. Of these cases, 15 had anterior circulation lesions (5 middle cerebral artery dissections, 5 anterior cerebral artery dissections, and 5 internal carotid artery dissections). We also excluded 3 basilar artery, 1 posterior cerebral artery, 1 anterior inferior cerebellar artery, and 14 PICA dissection cases. To compare the characteristics of EVAD and IVAD, 2 cases with VAD lesions extending from the extracranial to intracranial portions of the VA were also excluded. A flow chart describing case selection is shown in Fig. 1.

From our database, we ultimately identified 10 cases (6 females, 4 males; average age, 36.7 ± 6.93 years) with EVAD. For the IVAD cohort, 113 cases (37 females, 76 males; average age, 56.9 ± 12.6 years) were included in this study. The average age at onset was significantly higher in the IVAD cohort ($p < 0.001$). Of the 10 cases with EVAD, 3 had bilateral VADs; 17 of the 113 IVAD cases had bilateral lesions. Of the 13 EVAD lesions, 7 were located on the left side and 6 were on the right. The details of the EVAD cases are summarized in Table 1. The IVAD cohort included a total of 130 lesions, including 17 cases with bilateral lesions, 52 left-sided lesions, and 44 right-sided lesions; there was no significant difference associated with the side on which the lesions occurred.

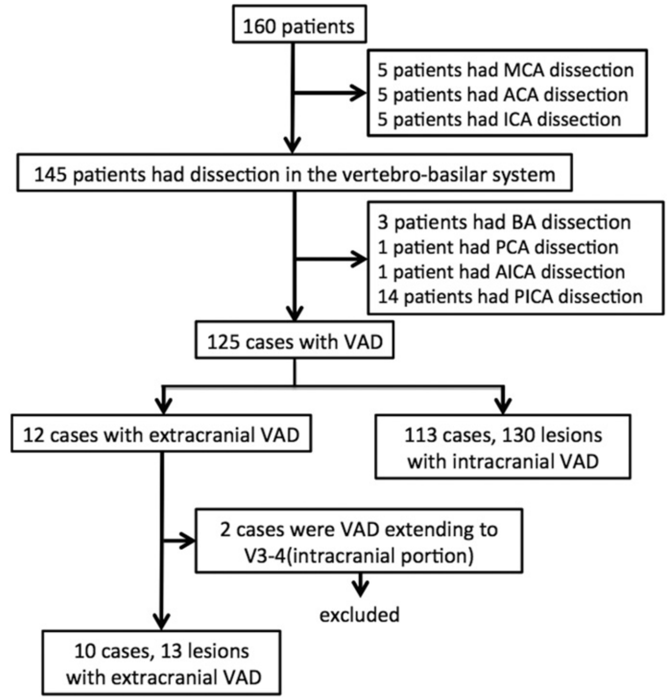

Fig. 1. Study flow chart. Abbreviations: ACA, anterior cerebral artery; AICA, anterior inferior cerebellar artery; BA, basilar artery; ICA, internal carotid artery; MCA; PCA, posterior cerebral artery; PICA, posterior inferior cerebellar artery; VAD, vertebral artery dissection.

Concerning the initial symptoms, all cases with EVAD (10 cases, 100%) experienced neck pain, whereas neck pain or headache was reported in 59 cases (52.2%) with IVAD ($p = 0.05$). Other symptoms, such as dizziness/vertigo and nausea, were significantly more common in patients with EVAD ($p < 0.001$) than in those with IVAD. In the EVAD cohort, 6 cases had precipitating events, such as minor trauma ($n = 1$) or exercise ($n = 6$); precipitating events were associated with IVAD onset in 15 cases (1 minor trauma, 14 exercise). Three cases in the EVAD group did not report precipitating events. There were no statistically significant differences in the number of these events between the groups. Hypertension and alcohol consumption were significantly more frequently associated with IVAD onset than with EVAD onset ($p < 0.001$ and $p = 0.001$, respectively). Although the rates of diabetes mellitus and histories of smoking were higher in the IVAD cohort than in the EVAD cohort, there were no statistical differences between the groups.

In our cohort, the majority of EVAD cases resulted in ischemic stroke ($p < 0.001$), and other cases without ischemic stroke or SAH occurred more frequently in the IVAD group ($p = 0.001$, Table 2). Of the 113 IVAD cases, 22 (19.5%) and 17 (15.0%) had ischemic stroke and SAH, respectively. For SAH grading, we used the world federation of neurosurgical societies (WFNS) SAH grading system, and the 17 SAH cases broke down into 4 cases of grade I, 3 cases of grade II, 3 cases of grade III, 4 cases of grade IV, and 3 cases of grade V.

3.2. Imaging studies

At the initial presentation, all EVAD lesions were evaluated using MRI, DSA, and CTA, but ultrasonography was not performed in one case (two lesions) of EVAD. Of the 113 IVAD cases, MRI was not performed in 8 cases (10 lesions) as these patients underwent emergency